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ABSTRACT

Four experiments were conducted on the interrelationship between semantic and syntactic structures. The former were specified by the method of restricted associations, and the latter by traditional grammatical analysis. In all experiments subjects were required to generate sentences from sets of given words. The generated sentences were studied as a function of (1) number of words given; (2) types of relations (free associations, restricted associations, or random words); (3) types of restrictions (Superordinates, Coordinates, Subordinates, Similars, Locations, Parts, Foregoing Words, or Following Words); (4) directions of relations (forward or backward); (5) strength of associations; (6) frequency of stimuli; (7) information given; and (8) instructional sets (creative, common, or control sentences). With the exception of the stimulus frequency, all independent variables had differential effects upon the sentences. In general, sentences were longer and given words were less often used "correctly" for large sets of given words, random pairs, Similars, backward pairs, low strength associates, known relationships, and the creative condition. Numerous interactions also were significant. (Author/KB)

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The University of Michigan

Department of Psychology

Translation of Restricted Associations into Sentences of the Natural Language

by

K. F. Riegel, R. Van De Moortel and Marilyn T. Zivian

Analysis of Meaning with Restricted Association Tests

Report Number 7

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NATIONAL INSTITUTE OF EDUCATION

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Translation of Restricted Associations into Sentences of the Natural Language

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Associations between words may be established either in the context of natural language through the co-occurrence of the words in spoken or written sentences, or in a physical context through the co-occurrence of the objects or events denoted by the words. Assuming the former interpretation, an association of two words can be considered a shortened sentence, the syntactical frame of which has become simplified and redundant through repetitions. Thus, if a S is asked to form a sentence from two associated words, the output may be regarded as the sentence underlying his association. His task, then, is to translate his association from a simplified code into natural language, and, differences in his performance may be explained by variations in associative strength between the two words if other variables do not interfere.

The following series of studies have been designed to investigate certain aspects of this interpretation. In general, the studies deal with the interrelation of semantic and syntactic structures. Semantic structures are specified by the method of restricted association. Syntactic classes and relations are analyzed in terms of traditional grammatical procedures. S's task is to form sentences from single words, from pairs of words, or triplets of words chosen from specific semantic fields. The frequency of the key word, the [illegible] of its associated responses, the types of relations, as well as various instructional conditions are manipulated in these studies.

Experiment I

Richard Van De Moortel and Meredith Bragg

Words were selected from free and restricted association norms and presented to Ss with the instruction to use them in generating sentences. First, the number of words to be used varied from one to three. Second, the types of relation between the words were varied. Pairs consisted of two randomly selected words, of a stimulus and a free associative response, or of a stimulus and one of three types of restricted associations (Superordinate, Coordinate or Subordinate). Third, the pairs with free and restricted associations were presented either in a forward or backward order. Fourth, the restricted associative pairs were compared with triplets consisting of the stimulus and two of the three restricted associations. Attempts were also made to compare the effect of the different types of restricted associations, but in general, this problem as well as the effects of strength of association and of the frequency of the stimulus will be treated more extensively in the next study of the series.

Methods

Ss were 20 undergraduate students at The Universtiy of Michigan: thirteen males and seven females.

A four-page test consisting of 35 items of one, two and three words each was constructed. Twenty stimuli were chosen from the Michigan Restricted Association Norms (Riegel, 1965). Eight of the stimuli were of low word frequency; they occur fewer than 130 times among four and one-half million words of the T-count by Thorndike and Lorge (1944). The five words of medium frequency occur between 240 and 270 times, and the seven words of high frequency more than 800 times. The stimuli were used in four sections of the test.

For section 1, ten of the 20 stimuli were randomly selected (controlling word frequency) and presented singly to Ss.

In section 2, all 20 stimuli were applied. One or two responses from the restricted association norms were added to each stimulus so that there were twelve items of two words and eight items of three words. Three types of restricted association were taken from the Michigan Restricted Association Norms: Superordinates, Coordinates and Subordinates. Generally, the most common associates were selected disregarding response overlap between categories. On the average the Superordinates were given 23 times by the 100 Ss of the norms, the Coordinates 37 times, and the Subordinates 22 times.

Section 3 consisted of five of the twenty stimuli paired with one free associate of high associative strength as determined from the norms by Riegel (1965). The most frequent associates often could not be used because they were also the most frequent restricted associates. The free associates chosen were approximately fourth or fifth in rank and were given on the average, 8 times by the 100 Ss of the norms.

Section 4 consisted of the same five stimuli as in section 3, but paired with words neither associated with the stimuli as free nor as restricted responses. These five words were chosen among the single responses of the Riegel norms. They were checked against those appearing as responses to the corresponding stimuli in the free and restricted association norms and were randomly assigned to the five stimuli.

Two test forms using the same items in different orders, but keeping the single stimuli at the beginning of the forms were applied. Of the ten single stimuli only five were used in each form. Furthermore, the word order within items was different for the two forms. Ss were given the mimeographed forms in a group session and were instructed to form 35 single sentences using all the words of each item. Equal numbers of the two test forms were distributed. No time limit was imposed and Ss were not told the relationships between the words in the pairs and triplets.

Results

Sentence Length

The shortest sentences, with an average of 7.1 words, were produced when only single stimuli were presented to Ss. Significantly longer sentences ($p<.01$), with an average of 9.6 words, resulted when pairs of words were given. Finally, triplets produced significantly longer sentences ($p<.01$), than sentences generated from two words. The average sentence length was 13.5 words, and thus, the increase over the paired words was larger than one word, i.e. larger than the increase in the number of stimuli given to Ss. The same is true of the increase in sentence length from the single word sentences to the word-pair sentences. The net effect was tested by subtracting one word from the average sentence length of the single word sentences, two words from the word-pair sentences, and three words for the word-triplet sentences. In spite of these more stringent conditions, the significance in sentence lengths was maintained for both comparisons ($p<.01$).

Next, the effect of the types of relations on sentence length was tested. Free, forward associations differed significantly from restricted forward associations ($p<.01$). The average sentence lengths were 7.8 and 9.6 words, respectively. Both types of word pairs produced significantly shorter sentences ($p<.01$) than pairs of associatively unrelated words for which the average sentence length was 10.9 words.

To compare forward vs. backward and free vs. restricted associations a two by two analysis of variance was applied. None of the main nor the interaction effects were

significant. The average sentence lengths were 7.8 and 9.4 for the forward and backward free associations, respectively and 9.6 and 9.4 for the forward and backward restricted associations, respectively. Since the difference in sentence length was relatively large for the free associations and close to zero for the restricted associations, the former relationship seems to be less easily reversible than the latter, even though the effect did not quite reach significance. The reversibility of restricted word pairs might also be dependent on the type of restrictions. For this reason comparisons were made between the three sets of restricted associations (Superordinates, Coordinates, Subordinates).

Length did not differ between sentences generated from superordinated and subordinated word pairs. The average lengths were 9.2 and 9.0, respectively. This result is not surprising since the ordered relations within the pairs are the same; only the roles of the stimulus and response terms are interchanged. Surprisingly, however, sentences formed from coordinated, i.e. reversible word pairs, were almost one word longer (10.0) than those incorporating the irreversible word relations. Even though these comparisons did not quite reach the levels of significance ($t = 1.4$ in both cases), words that ought to be most readily interchangeable in position (Coordinates) produced longer rather than the shorter sentences generated from irreversible word pairs (Superordinates and Subordinates).

Sentence Structure

For grammatical descriptions of the sentences traditional classifications have been applied. Such a system offers itself for convenience but has its limitations in that it presupposes correct and precise grammatical constructions. Whenever sentences are incorrect awkward or vague--as they are at times in our studies--its application is difficult and open to error. The following classes were used: subject, object, predicative noun (This animal is a lion), adverbial modifier of location or time (The lion lives in a cage), and attributes (The lion is a type of animal).

Insert Table 1 about here

First, the sentences generated from single words, word pairs, and triplets were compared. The first three columns of Table 1 show the results irrespectively of whether the slots were filled by the stimuli or by the responses, and irrespectively of whether they constitute free associative, restricted associative or random pairs of words. Under all conditions the words are used slightly more than one-third of the time as subjects. The usage of the words as objects declines rather markedly from the single to the triplet condition. This change is compensated by an equally marked increase in the percentages of predicative nouns and attributes. Presumably, under the triplet condition one word is always used as the subject whereas the other two are fairly equally distributed over the remaining categories. Under the single and pair conditions the usage of the words is more narrowly restricted to the classes of subjects and objects.

Second, the different types of relations were compared. Here, consideration will be given separately to the stimulus and response terms. The occurrence of the stimuli as subjects of the sentences is greatest for free associates and least for the random pairs. This change is compensated by the greater usage of the stimuli as adverbial modifiers and attributes, as well as by the greater occurrence of the response terms as the subjects of the sentences. As the occurrence of the response terms as subjects increases, their usage as adverbial modifiers decreases.

Third, we determined to what extent the usage of the stimuli in sentences is similar to that of the responses. A good fit of the two distributions would indicate that the relation is reversible; a poor fit indicates a directedness in the relation. We determined the degree of congruence in the distributions of the words over the grammatical classes by chi-square tests. A good fit was obtained for the random pairs. However, the fit was even closer for the stimuli and responses of the restricted associates. To explain this result one need only realize that 42% of the response terms were coordinates of the stimuli, i.e. the word relation involved was a reversible one.

The last comparisons were extended to the condition where a stimulus and two restricted associates were given. For these triplets we expected that the distribution of the response

terms--because of their greater number--should be more similar to the distribution of the stimulus terms than they were in the case of word pairs. A close match in the distributions of the first and second response terms of the triplets was detected. Thus, only their average frequencies were compared with the distribution for the stimuli and a close fit was found. Apparently, the more words given to Ss, the less important their relationships become. Under these circumstances words are incorporated more independently and, thus, their distributions over the grammatical classes resemble each other closely. Consistent with this finding, the overall distribution of words given in triplets, differed significantly ($p < .01$) from those given in pairs or singly.

Discussion

Sentences formed from three given words are significantly longer than those generated from two words, which in turn are significantly longer than those formed from single words. This result had been expected, if for no other reason, than that the number of words to be incorporated (one, two or three) directly lengthens the sentences. However, the increase was much greater than the numerical differences of the words given. Thus, the greater the number of words to be incorporated, the greater will be the number of additional, connecting words needed to make such an incorporation possible.

In the above statements, sentence length has been regarded as a function of the ease of combining words and, thus, of the number of words given. Sentence length has also been shown to vary with the type of relations between the given words. If these words had no relationship to one another as in the case of random pairs, sentence length was high. Sentences generated from words related as free or restricted associates were shorter. It is less certain, however, whether the former or the latter condition facilitates the formation of sentences.

Generally, restricted associates form proper subsets of free associates, and, thus, the choice of possible sentences ought to be narrower. In particular, the types of restricted associates used, namely superordinates, coordinates and subordinates are likely

to belong to the same form class as the stimuli and, thus, are paradigmatic associations (Jenkins, 1954; Ervin, 1961). The universe of free associates, however, includes as another subset, the set of syntagmatic associations, i.e. responses that are likely to occur near the stimulus in connected discourse, that belong to a different form class and cannot function as substitutes for the stimuli. The inclusion of syntagmatic associates in the set of free associative responses should facilitate the generation of sentences and should reduce the sentence length, whereas no such facilitating effect should be expected for restricted associations of the types used in the present experiment. Even though this expectation was confirmed, further explorations are needed. Experiment II will investigate paradigmatic and Experiment III syntagmatic associations.

For the same reasoning, forward in comparison to backward associations should facilitate the formation of sentences. Many scientists have regarded the context of the natural language as the origin of word associations(Ervin, 1961; McNeill, 1963). In particular, forward associations are more likely to represent sentence frames of the natural language. Since, the restricted associations used are closely related to the paradigmatic type of associations and since the latter are not likely to have originated from running linguistic context, but rather from contextual substitutions or from general experiences of the physical world, the backward order of the word pairs was not expected to effect sentences generated from restricted associative word pairs as strongly as those from free associative pairs. Even though this prediction was not confirmed by statistical tests, the differences between the means make such an interpretation suggestive.

The grammatical structures of the sentences were primarily analyzed to determine the reversibility of the various word relations. For this purpose the distributions of stimuli and responses across grammatical classes were compared by chi-square tests. The distributions of the stimuli and responses of free associative pairs were most dissimilar, indicating a distinct direction between the words. Randomly selected word pairs on the other hand, revealed the highest degree of congruence in the distributions, whereas, restricted associative pairs were closer in degree of similarity to the latter than to the dissimilar pairs of the free associations.

Again, this last result has to be explained on the basis of the particular types of restricted associations involved. Forty two percent of the word pairs were coordinates for which a high degree of similarity in the grammatical distributions had to be expected. A high degree of congruence was also observed when two, rather than one, restricted associates were presented with the stimulus to Ss. Apparently, the larger the number of words to be implemented in the sentence, the more even their distributions over the grammatical classes will become.

Experiment II

Richard Van De Moortel

In the first experiment Ss were not told how the given words were related to one another. Since Ss informed about the relations are expected to score significantly different from those not told, the present extension of the experiment was undertaken. In the second study specific comparisons are made between Superordinates, Similars, Parts, and Locations. Superordinates and Similars represent logical relations or verbal abstractions and Parts and Locations represent physical or infralogical relations derived from observations of objects or events. Since words associated in any of these ways are of the same form class as the stimuli (nouns), they may also be regarded as paradigmatic associations. In a narrower sense, however, paradigmatic associations have been defined as words that can function as substitutes for the stimuli in linguistic context. Using this definition, only Similars and--to some extent--Superordinates can be regarded as paradigmatic associations. Parts and Locations, even though they are of the same form class, are likely to occur near the stimulus in running context rather than as substitutes and, thus, serve syntagmatic functions.

Methods

Twenty undergraduate students at the University of Michigan primarily in fields other than psychology, served as Ss. There were ten females and ten males.

Two test forms were constructed. Each included the same set of 64 pairs of nouns, one a stimulus and the other an associate from the Michigan Restricted Association Norms (Riegel, 1965a). In one of the two forms Ss were not told how the words in each pair were related, whereas in the other the relationships were indicated. Ten Ss were run under each condition.

The four categories of restricted associations (Superordinates, Similars, Parts, and Locations) were chosen because they do not elicit appreciable response overlap and were expected to have fairly precise grammatical counterparts or representations. Within each task, the association strengths of the word pairs and the frequency of the stimuli were varied, so that there were four possible combinations: high frequency stimuli paired with high or low strength associates; low frequency stimuli paired with high or low strength associates. A high frequency stimulus appears more than 100 times among one million words according to the general count of Thorndike and Lorge (1944); a low frequency stimulus appears less than 50 times. A high strength associate occurs more than 40 times out of 100 responses to a particular stimulus; a low strength associate appears less than 3 times.

Sixty four pairs were chosen, 16 for each type of restriction, or four to each cell within each category. The order of the pairs within the lists were randomized and the order of the stimulus and response within each pair was balanced. For further reduction of the word-order effect, words were printed above one another on the test forms.

Ss were instructed to form a sentence from each of the word pairs, using all words as nouns only, and keeping sentences as short as possible. The two forms were individually administered and each randomly assigned to one-half of the Ss.

Ss were considered to have used a pair "correctly" when the relationship from the norms was translated explicitly into a sentence. "Correctness" was judged on the basis of standard sentence frames, which are reformulations of the instructions used for the collection of the Restricted Association Norms. Reasonable variations of these frames were also considered "correct". The following frames were regarded as representative:

Superordinates:	A (S)	is a (type, sort, kind of, etc.) (R)
Similars:	A (S or R)	is (like) a (S or R).
Parts:	A (S)	is part of a (R).
Locations:	A (S)	is found (in, at, by, etc.) a (R).

Results

Sentence length and "correct" usage

Sentences were shortest (6.6 words) for Ss who had not been told the relationship of the words, and when high frequency stimuli were presented with high strength Part associates. Sentences were longest (9.7 words) when Ss were told the relationship and when high frequency stimuli were presented with low strength Similar associates. "Correct" usage was highest (100%) when high frequency stimuli were paired with high strength Location responses and when the relationship was known. "Correct" usage was lowest (22%) when high frequency stimuli were paired with low strength Similar responses and when the relationship was not known.

Insert Table 2 about here

Without exception, sentences were longer (8.5 words) and percent "correct" higher (74%), for Ss who were told the relationships. For Ss who were not told the relationships, the corresponding figures are 7.7 and 55% (see last line of Table 2). Knowledge of the relationship increases the "correct" usage, but it also lengthens the sentences.

When comparing the different types of restrictions, infralogical tasks were found to be easier than the logical tasks, i.e. more often "correct" and shorter. As shown in the

first two lines of Table 2, word pairs involving logical relations were used "correctly" in 50% of the cases, with an average sentence length of 8.3 words. Pairs involving infralogical relationships were used "correctly" in 80% of the cases, with an average sentence length of only 7.8 words. In particular, Similars were most difficult to handle; percent "correctness" was by far lowest and mean sentence length a good deal higher than for the other categories. Superordinates were next most difficult. Although percent "correctness" was 18% higher than for Similars and sentence length .6 words shorter, this category was still more difficult to use than either of the two infralogical categories. Of these latter two categories, neither had a distinctly greater facilitating effect, but Parts were used "correctly" somewhat more often than Locations, and required shorter sentences.

The effect of the strength of associations is shown in lines 7 and 8 of Table 2. When high strength associates were paired with the stimuli, sentences were shorter and percent "correct" usage slightly higher than when low strength associates were involved. This result was consistent regardless of whether the relationships were known or not.

As shown in lines 9 and 10 of Table 2, the frequency of the stimulus had no effect on the two measures used. Since in every comparison, the results were either equal or near-equal, the factor of word frequency was omitted from the variance analyses. When sentence length was the dependent variable all major effects and all two-way interaction effects were significant ($p<.01$). For percentage "correct" only the types of restrictions and the knowledge of the relationships, as well as the interaction between the former and associative strength reached the level of significance ($p<.01$).

Sentence structure

The results of the grammatical analysis are presented in Tables 3 and 4. Superordinates and Locations are most easily and most consistently expressed in sentences. When Ss were not informed about the relationship involved, the major portion of the "correct" usage of Superordinate pairs can be accounted for by a sentence of the form: "A dog is a domestic animal." As shown in Table 4, the stimulus is most often used as the subject and the superordinated associate as a predicate noun. However, when Ss

were told how the two words were related, the "correct" usage of the word pairs went up and a large portion of the sentences took the form: "A dog is a type of animal." Here, the stimulus is still the subject of the sentence, but the associate is an attribute which modifies a predicate noun.

Insert Tables 3 and 4 about here

For the Locations, regardless of knowledge of the relationship, the major part of "correctly" generated sentences was of the form: "The knife is in the kitchen." Here, the stimulus functions as the subject and the associate as the object of a prepositional phrase. When the relation was known, this form appeared somewhat more often than when the relation was not known.

The results are more difficult to interpret when the relations of Parts and Similar were involved. For Parts regardless of knowledge of the relation, two different sentence types contributed about equally to the very high percentages of "correctly" used relations: "A house has a door." and "The door of the house is green." In the first case, the stimulus is used as the subject and the associate as the direct object. This form was more prevalent when the relationship was not known. In the second case, the associate is used as the subject and the stimulus as an attribute which modifies the subject. Here the stimulus is listed as an attribute. This form was more prevalent when the relation was known.

Items involving similarity relations were least often "correctly" used. Very frequently, stimuli and associates have been used interchangeably, particularly, as the subject of the sentence. When the relationship was not known, and when the stimulus functioned as the subject, the associate was frequently used as direct object: "The insect ate the bug", or particularly, when the relationship was known--as predicate noun: "An insect is a bug". When the relation was not known and the associate functions as subject, similar results were obtained, except that the stimulus was used more often as

a direct object than as a predicate noun, whereas when the relationship was known the stimulus was most often used as the object of a prepositional phrase which modifies the subject: "A bug is like an insect."

As a comparison of the columns of Tables 3 and 4 shows, neither the stimuli nor the responses of the logical relations (Superordinates and Similars) are used as adverbial modifiers of locations. This grammatical category finds almost exclusive usage for the response terms of the Locations. On the other hand, neither stimuli nor responses of the infralogical relation (Parts and Locations) are used as predicate nouns.

In order to determine differences in the grammatical distributions of the words chi-square tests of independence were computed separately for the conditions of: relations known vs. not known, and stimulus vs. response terms. In all four cases, significant differences were detected ($p<.001$). Subsequently, paired comparisons of the distributions were made separately for the stimuli and for the responses as well as for the conditions where the relations were known and where they were not known. All pairs of stimulus distributions differed significantly from one another ($p<.01$) except for the Superordinates and Similars both when the relation was known or not known. The same results were obtained for the response distributions ($p<.001$). Here, however, the distributions of the Superordinates and Similars were found to be significantly different when the relation was not known ($p<.005$). Only when these two relations were known did the distributions resemble each other closely.

Finally, the reversibility of the stimulus-response relations was analyzed by testing for the goodness of fit between each of the corresponding stimulus and response distributions. As shown in Tables 3 and 4, the similar relation is most clearly reversible, whereas the Locations and Parts have the lowest degree of reversibility.

Discussion

Knowledge of the relations produced greater "correctness" of usage over and above all other variables. However, knowledge of the relations produced longer rather than

shorter sentences in nearly all cases. This finding is rather paradoxical, because shorter sentences would seem to indicate greater ease in relating the two words of the pairs. Thus, knowledge of the relations seems to make the tasks harder for Ss. Since the excess number of words per sentence has been primarily used for the addition of subordinate clauses and apostrophic modifiers which contribute nothing essential to the sentence, knowledge of the relationships seems to induce an attitude upon Ss that a simple formulation incorporating the relationship is neither sufficient nor desirable. This interpretation is also supported by the observation that even though half the Ss were told how the words were related and the relationships were clearly defined for them, they rarely produced sentences such as: "A bug is similar to an insect." or "Glass is part of a porthole." The relationships were very frequently transformed into more complicated sentences. The question of Ss task attitudes will be analyzed more fully in the fourth experiment of our series.

Knowledge of the relations had a greater effect on logical than on infralogical tasks. Infralogical relations seem to be more firmly embedded in the experience or habits of the Ss. They represent not only relations between words, but also relations between the objects or events denoted by the words. Hence, word pairs from these tasks were expected to be more effectively used when the relationship was not given and would consequently improve less than the logical tasks when knowledge of relationships was added. This interpretation is congruent with the one in terms of paradigmatic and syntagmatic types of associations even though this classification is somewhat too general for the present purpose. Logically related responses (Similars and Superordinates) are likely to function as substitutes for the stimuli in connected discourse, and thus, form subsets of the paradigmatic associations. Infralogically related responses (Parts and Locations) are likely to occur near, but not in the same slot as the stimuli, and thus, represent syntagmatic associations.

The result that infralogical relations were more easily handled than the logical ones, contradicts findings from other experiments with restricted associations on young adult

Ss (Riegel, 1965c). Whereas the results from the former studies have been interpreted in terms of the natural development of higher skills in the manipulation of words and concepts, the present findings suggest that logical categories are better suited for superlingual processes, but not necessarily for concrete operations like using such word pairs in generating sentences. In other words, the differences in the results between former and the present study can be explained by task differences.

High frequency stimuli paired with strong associates were expected to produce greater percentages of "correct" and shorter sentences than any of the other combinations. This hypothesis was only partly substantiated. Frequency of the stimuli had no significant effect. However, association strength affected both percent "correctness" and sentence length in the predicted manner. The lowest percentages and the longest sentences occurred when the strength of the association within the word pairs was low. The highest percentages and the shortest sentences occurred when the association strength was high.

Analysis of the grammatical usage of the responses in the generated sentences indicates that they are used quite differently from one another except when they come from Superordinate and Similar pairs. The same is true of the grammatical usage of the stimuli. The distributions of the stimuli and responses are closely parallel to one another for the Similars, and thus, the word relation is reversible. They differ most widely for the pairs of Locations and Parts. Thus, the stimuli of these word pairs take quite a different place in the sentences than the responses.

Experiment III

Barbara Trelfa and Marilyn T. Zivian

In the preceeding experiment, Ss generated sentences from paradigmatically related words; i.e from words belonging to the same form class and/or likely to function as substitutes for one another in linguistic context. The latter criterion of paradigmatic word relations readily applies to the Synonyms and to a lesser extent to the stimuli and their superordinates. It becomes inappropriate, however, when words denoting locations or Parts are given. Even though these words belong to the same form class as their stimuli, they are not likely to function as substitutes for one another in linguistic context.

In comparison to the usage of paradigmatic word pairs in sentences, the present study analyzes the effect of syntagmatically related words, i.e. words that belong to different form classes and are not likely to function as substitutes for one another in linguistic context. Words syntagmatically related to the stimuli were selected from the tasks of Foregoing and Following Words of the Michigan Restricted Association Norms (Riegel, 1965a),i.e. from tasks in which Ss had been requested to respond with words that they considered to occur near the stimuli in linguistic context.

Method

Thirty-six undergraduate students at the University of Michigan served as Ss. They were randomly assigned to three groups. Each group received one of the three word pairs associated with a particular stimulus word. Between the groups, all possible word pairs were used equally often.

Sixteen words (eight nouns and eight verbs) of high (above 700) or of low frequency (below 400) as determined from the Thorndike-Lorge count (1944) were selected among the stimuli of the Michigan Restricted Association Norms (Riegel, 1965a). The eight nouns elicited adjectives as Foregoing Words (average associative strength 18%) and verbs as Following Words (average associative strength 10.9 %). The eight verbs elicited noun responses both as Foregoing Words (average associative strength 18.5%) and as Following Words (average associative strength 25.2%). Thus, 16 three-word sequences were selected; eight adjective-noun-verb sequences and eight noun-verb-noun sequences. All ordered pairs of each sequence were presented as stimuli to Ss. For example, adjective-noun-verb sequences were split into adjective-noun, noun-verb, and adjective-verb pairs. Table 5 shows the original sequences and the pairings used for each of the three groups of Ss.

Insert Table 5 about here

Ss were instructed to write a sentence using each word pair with the stipulation that the word order within the pair be retained. They were not told how the words in a pair were related to one another. The number of times the missing word from the original trio was supplied in the proper position in Ss' sentences was used for the evaluation of their performance.

Results

Table 6 shows the proportion of times Ss supplied the missing words when generating the sentences. Comparisons are made between the adjective-noun-verb and noun-verb-noun sequences, between the high-frequency and low-frequency stimuli, and between high (above 16%) and low (below 16%) associative strength.

Insert Table 6 about here

The differences between the proportions were tested for significance. On the average, the missing words were correctly supplied more often when the Foregoing and Following Words were given as pairs than when either of the other two conditions were applied ($p < .05$; see last line of Table 6). For noun-verb-noun sequences, for words associated with high frequency stimuli and for word pairs with high associative strength, the missing words were supplied significantly more often when the Foregoing-Following Words rather than when the stimuli and the Foregoing Words were given ($p<.05$). Also, it was easier to supply the correct words when they were from noun-verb-noun sequences then when they were from adjective-noun-verb sequences. These significant differences were found when the stimuli and Following Words or when the Foregoing Words and the Following Words were given for a particular stimulus ($p<.05$).

When the word to be supplied was a verb it was given significantly more often when Ss were presented with noun-noun pairs than when they were presented with adjective-noun pairs. ($p<.05$). When the missing word was a noun it was supplied significantly more often when Ss were given verb-noun pairs than when they were given adjective-verb pairs. (The significance of both the last comparisons are not listed in Table 6).

Discussion

Two results of the present experiment are particularly interesting. One is the marked increase in "correct" completions when Ss were given the Foregoing and Following Words, i.e. when the original stimulus of the associatives had to be supplied and properly located between the two given words. The other is the greater proportion of "correctly" completed sentences when the words to be supplied were members of noun-verb-noun rather than adjective-noun-verb sequences.

The former result seems to imply that syntagmatic associations which go both foreward and backward, converging upon the same word, determine that word more strongly than two adjacent, superceded syntagmatic associations which proceed in one direction only (foreward in the condition Foregoing Words-Stimuli; backward in the condition Stimuli-Following Words). This effect seems to be particularly marked for the noun-verb-noun sequence, the high frequency stimuli, and high associative strengths.

The second finding that the proportion of correct completions is greater for noun-verb-noun sequences than for adjective-noun-verb sequences is not surprising because noun-verb-noun sequences contain paradigmatic as well as syntagmatic associations. Whenever the missing word was a noun in the noun-verb-noun sequences, Ss were given another noun as a member of a noun-verb or verb-noun pair. Apparently, the paradigmatic effect between the two nouns supercedes the backward and forward syntagmatic effects of the other pairs (adjective-noun, and noun-verb).

In particular, the proportions of nouns correctly supplied for either of the two noun slots in noun-verb-noun sequences was greater than the proportion of nouns correctly supplied in adjective-noun-verb sequences. This is the more surprising since we know already that the slot in the middle of the sequences is more readily filled than either of the end positions. The nummber of verbs correctly supplied was also greater for noun-verb-noun sequences than for adjective-noun-verb sequences. This result is partly explained in that in the former sequences the missing verb had the benefit of both forward and backward

syntagmatic association effects (noun-verb, and verb-noun), whereas in the latter sequences two foreward syntagmatic effects (adjective-verb, and noun-verb) are present of which the first is merely an indirect one mediated by the noun. However, it could also be argued that in noun-verb-noun sequences the missing verb was usually transitive while in adjective-noun-verb sequences the missing verb tended to be intransitive. One would expect transitive verbs to have higher syntagmatic association strengths than intransitive verbs (Erwin, 1961).

In conclusion it should be realized that many factors determine jointly the results of the present study and, at least the following variables ought to be considered for a complete analysis:

- frequencies of the stimuli, the given words, and the missing words
- form classes of the stimuli, the given words, and the missing words
- strength of association between the given words, and between the given and missing words.

Even though all factors have been controlled as well as possible, a complete analysis of all main and interaction effects has not been attempted in the present study. Even if we had succeeded in such an analysis, the interpretation of the finding would have become an extremely complicated matter. For this reason we restricted our analysis to the most obvious factors that determine the success of Ss performance.

Experiment IV

Irina Weiss-Marbach and Richard Van De Moortel

In the first three experiments substantial interpersonal variability in sentence length was noted which makes comparisons of grammatical structures difficult unless it is controlled. In particular, many Ss avoided generating the simplest sentences possible, but were inclined to embellish the sentences unnecessarily. The present study analyzes sentence length and percentage "correct" as a function of orientational sets.

Methods

Ss were 20 female students at the University of Michigan between 18 and 25 years of age.

The test contained 16 pairs of nouns, one a stimulus from the Michigan Restricted Association Norms (Riegel, 1965a) and the other a response with an associative strength of at least 30% with little or no associative overlap with the responses from other categories. Eight of the pairs represent superordinate, the other similar relations. The order of pairs was alternated, but not the order within pairs. The test was divided into two parts. Both parts were given to Ss in a group session which lasted about one hour. In the first part Ss were simply instructed to generate sentences for each word pair. The second part included special instructions (orientational sets) asking Ss to generate first a "sentence which you think most people would write" (common sentences) and then " a sentence which you think creative people would write," (creative sentences). The relationships between the words were given to Ss. Ten pairs (five of each type of restrictions) were identical to those of the first part. Three additional pairs for each relationship were different to prevent, or at least to control, the copying of sentences previously produced. Since no differences between these sets of pairs were detected in the analysis of the results, we shall disregard this distinction.

Results

As shown in Table 7, sentences are shorter and percentages of "correctness" are higher for Superordinates than for Similars. In comparing the instructional sets, creative sentences are longer, but the word pairs are less often used correctly than in common sentences. Generally, the results for the control sentences lie between the other two conditions. No interaction between types of restrictions and instructional sets is apparent.

Insert Table 7 about here

The results have been confirmed by variance analysis. The differences in sentence lengths between types of word relations ($p<.025$) and between orientational sets ($p<.01$) but not the interaction effect were found to be significant. Comparisons with t-tests revealed that only the difference in length between creative and control sentences ($p<.005$) but not between the latter and common sentences was significant. In an analysis of the percentages of "correct" usage only the difference between the types of restrictions was found to be significant ($p<.01$).

Insert Tables 8 and 9 about here

As the chi-square comparisons of Tables 8 and 9 show, stimuli and responses of Similar pairs are more often used grammatically in the same manner than the members of Superordinate pairs. This finding is consistent with the results of the second study of this series.

Chi-square tests of independence of the stimuli, of the responses, of Superordinates and of Similars respectively, indicate that their grammatical usage, in general, was dependent upon the instructional sets (for Similar and Superordinate responses and for Superordinate stimuli, $p<.05$; for Similar stimuli, $.10>p>.05$). In particular when all response distributions were compared with one another and all stimulus distributions were compared with one another, grammatical usage varied most between the common and creative conditions (for Similar and for Superordinate responses, $p<.01$; for Superordinate and for Similar stimuli, $p<.05$). The next greatest effect was produced between the common and control conditions (for Superordinate stimuli, $p<.02$; for Superordinate responses and Similar stimuli, $.10>p>.05$).

Discussion

According to the findings of our second experiment, Similars produce longer sentences and smaller percentages of "correct" sentences than Superordinates. This finding has been

confirmed without exception. It is difficult, however, to explain this result. Undoubtedly, Similars are substitutes for one another and can readily be used in enumerations but, as the greater sentence length indicates, Ss are not using Similars in this manner. If we can show that these differences covary with those produced by orientational sets we may find some clues for an interpretation.

In predicting differences in sentence lengths and in percentages "correct" as a function of orientational sets, it seems quite reasonable that common sentences should be shorter and simpler than those produced without any directed orientation (control sentences), but it is not apparent why creative sentences should be longer than both the control and the common ones. The instruction to produce creative sentences should not merely lead to the addition of words to the sentences, (even if "fancy" ones), but to more sophisticated grammatical constructions which could bring about a reduction in sentence length.

Creative sentences less often include the word pairs in their "correct" use than both the control and the common ones. Thus, the results confirm the findings of the second experiment, that even when Ss are informed as to how pairs of words are related to one another, they seem to find it neither desirable nor sufficient to make short, simple statements of the relations, similar to those sentence frames on which the judgement of the "correctness" of the sentences has been based. When asked to produce creative sentences, Ss incorporate novel associations into the sentences, but not necessarily in the most expedient manner. Thus, the sentences become longer and the percentage of "correct" use of the word pairs is lowered. Since the same results were obtained when sentences were produced from pairs of Similars, the results seem to covary with those obtained under the creative condition, i.e. the intuitively simple task of incorporating two words which function as substitutes for one abother leads to an expansion of the sentences which is comparable to the changes produced under the creative instructions.

Conclusions

All experiments reported in this paper served as exploratory studies of response variability in sentence production. The first experiment dealt with variation as a function of the number of words given (one, two, or three), types of relations (Superordination, Coordination, or Subordination), and the direction of the relations (forward or backward). Sentences increased in length as the number of words to be incorporated increased and were longer for unrelated word pairs than for either free or restricted associated pairs. Sentences produced from free, forward associations were shorter than those produced from restricted, forward associations. Backward, free associations produced longer sentences than forward, free associations, while there was almost no difference in sentence length between sentences generated from backward and forward restricted associations. Coordinates, which one would expect to be reversible, gave rise to longer sentences than superordinate or subordinate word pairs. Thus, in general, directed word pairs like the free, forward associates produced shorter sentences than pairs in which the directedness was less strong as for the unrelated words and for the Coordinates among the restricted associates, particularly when given in backward order.

The degree of reversibility was tested by comparing the grammatical distributions of the stimuli and responses. When the words were members of restricted associated pairs they were clearly reversible. When triplets of words were presented, the distribution of the grammatical usage of the two responses resembled more closely the usage of the stimulus than the responses of word pairs. Apparently, the greater the number of words given to Ss, the less important becomes the relationship between the words.

In the second experiment the following factors were studied: information provided (restriction known or unknown), types of restrictions (Superordinates, Similars, Parts or Locations), restricted association strength (high or low), and frequency of the stimuli (high or low). In general sentences were longer and "correct" usage was higher when Ss were told the relationship between the words. The infralogical associations of Parts and Locations were more easily handled than the logical associations of Superordinates and

Similars: correct usage was higher and sentences shorter. Within the logical associations, Similars were more difficult to put in sentences than Superordinates. Words related by high association strength produced shorter sentences and more "correct" usage than pairs with low association strength. However, the frequency of the stimuli had no effect on either of these two measures. In terms of the grammatical usage, stimuli and the responses which they elicit were used differently from one another except for those of the Superordinates and Similars.

In the second experiment, Ss generated sentences from paradigmatically related words; i.e. from words belonging to the same form class and/or likely to function as substitutes for one another in linguistic context. The latter criterion of paradigmatic word relations readily applies to the Synonyms and to a lesser extent to the stimuli and their superordinates. It becomes inappropriate, however, when words denoting locations or parts are given. Even though these words belong to the same form class as their stimuli they are not likely to function as substitutes for one another in linguistic context.

In comparison to the usage of paradigmatic word pairs in sentences, the third experiment analyzes the effect of syntagmatically related words, i.e. words that belong to different form classes and are not likely to function as substitutes for one another in linguistic context. Words syntagmatically related to the stimuli were selected from the tasks of Foregoing and Following Words, i.e. from tasks in which Ss had been requested to respond with words that they considered to occur near the stimuli in linguistic context.

Furthermore, the effects of associative strength (high or low) and word frequency (high or low) were tested. Associative strength and word frequency had no systematic effect upon replacement of words in sentences. It was also found that syntagmatic associations which go both forward and backward facilitated the correct replacement of missing words significantly more than did syntagmatic associations which proceed in one direction, either forward or backward, only. If it were possible for Ss to make use of any paradigmatic association, then this factor, too, increased the number of "correct" replacements.

The fourth experiment analyzes performance as a function of orientational sets (creative, control, or common sentences) and two types of restricted associations (Superordinates and Similars). As was found in the second experiment, longer sentences and fewer "correct" sentences were generated for Similars than for Superordinates. The instruction to write creative sentences produced longer and fewer "correct" sentences than the instruction to write common sentences; the control sentences fell in between on both measures. Thus, sentences generated from the reversible and paradigmatic Similars and those produced under creative instructions covary in lengths and in percentages "correct". Instead of using the Similars in simple enumerations and instead of increasing the originality of the sentences by using more sophisticated grammatical constructions, the sentences become embellished with unnecessary details and, subsequently, become longer and incorporate the given words less often in the "correct" manner. If one wishes to have the given word pairs most accurately incorporated into sentences one should instruct Ss to form short and common sentences.

All four experiments presented served as explorations of the response variability in tasks of sentence production. Almost all conditions had a significant effect upon the dependent variables, namely sentence length, sentence structure, and the percentages of times in which the given words were used "correctly". Thus, the results encourage us to extend our explorations and the remaining part of our paper will be devoted to the discussion of such extensions. More generally, an attempt will be made to locate the present type of investigation into the broader fields of semantic and syntactic analyses.

Syntax consists of a set of rules that inform a person how to generate grammatically well formed sentences from classes of words. These classes of words (parts of speech, grammatical classes, form classes) are in turn dependent on certain rules of morphology, such as rules of declension and conjugations. Both sets of rules are interdependent. Thus, in proper English sentences, a singular noun will be followed by a verb with an s-ending.

The rules of syntax and morphology differ widely between languages and seem to

represent nothing but conventions for linguistic communities. There exist, however, a subset of linguistic rules which are more universal and have attracted the interests of philosophers, logicians and mathematicians. These rules are tied to specific operators or functional words (particularly conjunctions and prepositions) and are closely related to the logical structure of language.

Aside from such specific words, the logical structure of a language is dependent upon certain classes of words which may be called semantic classes, such as the classes of coordinates, superordinates, parts, functions, etc. They are comparable to the grammatical classes but, generally, are narrower and represent proper subsets of the former.

The present investigations have been concerned with semantic classes and with the relations within and between such classes. In particular the interdependence of semantic and syntactic classes has been analyzed.

In spite of the considerable research activity brought about by Osgood's publication of the Semantic Differential (Osgood, Suci, and Tannenbaum, 1957), systematic, psychological explorations of semantic problems are still inadequate. Osgood, himself, regards the Semantic Differential as restricted to connotative aspects of meaning. Whereas the more general type of analysis of "associative meaning" proposed by Deese (1962) has not yet been sufficiently explored and suffers from some methodological limitations. The word-association techniques used does not necessarily elicit a sufficient number of related or overlapping responses to a set of stimuli. Unless the stimuli are preselected, the associative overlap is too thin to permit a comprehensive analysis of associative structure. For similar reasons, Rapaport (1964) had to impose limitations upon Ss' production by asking them to select the associations from given lists of words.

Regardless of the methodologies, all previous studies--as well as the author's attempts (Riegel and Riegel, 1963) in which restrictions are imposed upon Ss' responding by means of instructional sets--perceive of meaning as a field of words and word relations that centers around the key words or stimuli. In Rapaport's net analysis, various word

chains take off from and return in loops to the key words or to various responses. For Osgood, the key words or concepts themselves are interrelated in a higher dimensional, the semantic space, whereas Deese rejects the idea of deriving general labels for the semantic dimensions. The present author has described some denotative aspects of meaning in terms such as superordination-subordination, similarity-contrast, part-whole, etc. and aims for an empirical, psychological model similar to the formal theory of semantic structure by Katz and Fodor (1963).

Katz and Fodor conceive the key words as being at the top node of semantic tree diagrams. The number of branches represent the different senses or shades of meaning whose dimensionality is not fully detailed, however. Only recently have the principles of class inclusion (such as superordination), of synonymity and of antonymity been discussed by Katz and Postal (1964). Furthermore, these two authors have begun to analyze the most significant problem of the interrelationship of semantic and syntactic structures.

As mentioned before, the classes of the syntax are fewer and larger than the classes of a semantic system but, more important, syntax includes rules on the sequential order of these classes. Similar to the system of ordinal numbers in mathematics, syntactic systems include statements about ordered relations, whereas a semantic system does not necessarily include such statements and, thereby, resembles the system of nominal or categorical numbers. In as far as classes are necessary prerequisites for class relations and sequences, the semantic system is prior and more basic than the syntactic system. The following example may clarify the problems.

If a listener hears the first part of the sentence: "The banks are overflowing", a section of his semantic system will be activated, namely, the field representing the word BANK. Since this word has at least the distinct meanings of "monetary institution" and "borders of waterways", his expectations regarding the complete meaning of the message are relatively unclear. At the same time, he will have recognized the word BANK implicitly as a noun, particularly, since it was introduced as such by a definite article.

As the listener perceives the consecutive words, the ambiguities of the sentence

will be reduced and the meanings of the words thus far identified, will be blended. Thus, the perception of the verb OVERFLOWING, which has been introduced as such by the auxiliary verb ARE, makes a reference to a monetary institution less likely, even though it does not exclude this possibility altogether. After all, the complete sentence may read as: "The banks are overflowing with customers".

In Katz and Postal's theory the mechanisms called "selection restrictions" provide for the proper combination of words in meaningful sentences, i.e. provide that a word like BANK, when used in the sense of "monetary institution" goes together with items like MONEY, CREDIT, INTEREST, etc., whereas when used in the sense of "riverbanks" goes together with words like WATER, SUMMER, SWIM, etc.

Katz and Postal do not elaborate the psychological features of the "selection restrictions". In our own analysis, the successive reduction in the choice of the interpretations can be explained by associative ties. Thus, there will be a number of associates in the semantic field of the word BANK representing each of the two or more meanings of this term. The same will be true for the second key word in the sequence, namely OVERFLOWING, and the final interpretation of the sentence will depend on the number of shared words of the two or more semantic fields.

The interpretation of a message will be supported by, and will be dependent on, syntactic information. The identification of the first word as a noun will allow the listener to expect a verb in one of the following slots and this will reduce his semantic choice to a considerable extent. However, syntactic and semantic information interact in an even more intimate manner. Semantic relations such as superordination, coordination, location, partition, etc. can be regarded as reduced syntactic frames which have been acquired by Ss through the experience of well phrased sentences. Thus, a person will have established a notion of superordination after he has heard a number of sentences such as:

"The cow is an animal", "The dog is an animal", "The zebra is an animal", etc.

Even though the above interpretations seem reasonable enough, they can be based on sketchy evidentce, at best. The present series of experiments has been designed to analyze some of the interrelations between semantic and syntactic structures, whereby the former has been specified by the method of restricted associations and the latter in terms of traditional, grammatical procedures. All experiments were restricted to separate semantic fields by selecting key words and their corresponding sets of associates. Ss tasks consist of forming sentences from single words, or from pairs or triplets of words chosen from specific semantic fields. Thus, the present studies were not directed toward an analysis of the interactions between different semantic fields in syntactic context but such investigations seem now conceivable for explorations as well as experiments on sentence perception rather than on sentence production.

Summary

The present investigation includes four experiments on the interrelationship between semantic and syntactic structures. The former were specified by the method of restricted associations, the latter by traditional grammatical analysis. In all experiments, Ss were required to generate sentences from sets of given words. Sentence length, grammatical structure, and percent of "correct" utilization of the given words and word relations were analyzed as dependent variables.

The sentences generated were studied as a function of: number of words given (one, two, or three), types of relations (free associations, restricted associations, or random words), types of restrictions (Superordinates, Coordinates, Subordinates, Similars, Locations, Parts, Foregoing Words, or Following Words), directions of relations (foreward or backward), strength of associations (high or low), frequency of stimuli (high or low), information given (relationship known or unknown), and instructional sets (creative, common, or control sentences).

With the exception of the stimulus frequency, all independent variables had differential effects upon the sentences. In general, sentences were longer and the given words

were less often used "correctly"for: large sets of given words, random pairs, Similars, backward pairs, low strength associates, known relationships, and the creative condition. Numerous interactions were also significant.

Interpretations were given in terms of association theory, the semantic analysis by Katz, Fodor, and Postal and the distinction between paradigmatic and syntagmatic word relations. However, primarily the experiments were exploratory in nature and served to study the variability in sentence production as a function of instructional and individual conditions.

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Table 1

Percentages of Grammatical Classes Used in

Generating Sentences under Five Conditions

	Singles	Pairs	Triplets	Free A.		Restr. 1		Random		Restr. 2	
				S	R	S	R	1st	2nd	S	R
Subject	37	38	41	48	19	36	47	25	39	43	42
Object	34	24	12	31	27	16	20	25	28	13	11
Pred. Noun	8	6	19	0	1	11	8	4	5	20	18
Adv. Mod.	10	15	5	3	37	14	11	14	11	4	5
Attribute	5	14	20	13	10	20	11	22	10	18	20
Others	6	3	3	2	3	3	3	6	3	2	4
Chi-Square*		5.6	16.9**		42.8**		5.3		9.2		1.2

*Figures represent comparisons with each of the preceding columns
**$p<.01$

Table 2

Average Sentence Lengths and Average Percentages

"Correct" for Four Variables

	Rel.Known	Rel.Unknown	Average	Rel.Known	Rel.Unknown	Average
Logical	8.9	7.8	8.3	59	41	50
Infralogical	8.1	7.6	7.8	89	70	80
Superordinates	8.6	7.5	8.0	67	50	59
Similars	9.2	8.0	8.6	50	31	41
Parts	7.8	7.4	7.6	89	72	81
Locations	8.5	7.8	8.2	88	68	78
Hi Assoc. Str.	8.4	7.3	7.8	74	57	66
Lo Assoc. Str.	8.6	8.0	8.3	73	54	64
Hi Stim. Fr.	8.7	7.7	8.2	73	55	64
Lo Stim. Fr.	8.3	7.6	8.0	75	56	66
Average	8.5	7.7	8.1	74	55	65

Table 3

Percentages of Grammatical Classes Used in Generating

Sentences when S-R Relationships were Known

	Superordinates		Similars		Parts		Locations	
	S	R	S	R	S	R	S	R
Subject	60	27	55	52	38	56	68	15
Object	6	7	12	8	8	35	18	0
Pred. Noun	14	34	14	23	0	0	0	0
Adv. Mod.	0	0	0	0	10	0	0	67
Attribute	20	32	19	17	44	9	14	18
Chi-Square*		24.4**		3.1		53.5**		33.8**

*Figures represent comparisons with each of the preceding columns.
**$p < .01$

Table 4

Percentages of Grammatical Classes Used in Generating

Sentences when S-R Relationships were Not Known

	Superordinates		Similars		Parts		Locations	
	S	R	S	R	S	R	S	R
Subject	61	32	54	50	46	43	62	24
Object	11	13	20	21	9	41	22	10
Pred. Noun	8	33	15	21	0	0	0	0
Adv. Mod.	0	0	0	0	19	0	0	55
Attribute	20	22	11	8	26	16	16	11
Chi-Square*		24.5**		1.4		42.0**		77.2**

*Figures represent comparisons with each of the preceding columns.
**$p<.01$

Table 5

Word Sequences, the Ordered Pairs Presented to Each Group of Ss, and the Number of Correct Completions

Sequences*						Presented Pairs			Correct Compl.		
Adjective		Noun (St)		Verb		Gr. 1	Gr. 2	Gr. 3	Adject.	Noun	Verb
soft	27	mattress	57	sleep	9	A-N	A-V	N-V	1	0	2
sticky	19	glue	90	sticks	14	N-V	A-N	A-V	0	1	2
large	22	intestine	28	digest	12	A-V	N-V	A-N	0	2	0
heated	17	controversy	57	raged	7	A-N	A-V	N-V	1	0	0
bright	26	sun	M	shines	19	A-V	N-V	A-N	3	4	1
small	12	child	M	plays	7	N-V	A-N	A-V	0	3	0
little	7	bird	M	flies	28	A-N	A-V	N-V	1	2	4
long	14	road	M	winds	5	N-V	A-N	A-V	0	1	0
sums									6	13	9

Noun		Verb (St)		Noun		Gr. 1	Gr. 2	Gr. 3	Noun	Verb	Noun
doctor	31	heals	190	wounds	23	N-V	N-N	V-N	3	3	3
thief	23	steals	360	money	41	N-N	V-N	N-V	3	8	0
oven	15	bakes	313	cake	59	V-N	N-V	N-N	1	3	6
water	18	freezes	190	ice	15	N-N	V-N	N-V	5	5	1
river	28	flow	700	sea	8	N-N	V-N	N-V	4	6	2
children	14	play	M	games	16	V-N	N-V	N-N	7	7	1
author	7	writes	M	letter	33	N-V	N-N	V-N	0	2	0
eyes	11	see	M	world	7	N-V	N-N	V-N	0	1	2
sums									23	35	15

*The figures behind the adjectives and nouns in the first column indicate the associative strengths of the Foregoing Words; the figures behind the nouns (St) and verbs (St) in the second column indicate the word frequency according to the Thorndike-Lorge T-count (1944); the figures behind the verbs and nouns in the third column indicate the associative strengths of the Following Words.

Table 6

Proportions "Correct" for Two Types of Sequences, High and Low Frequencies of Stimuli, and High and Low Associative Strengths of Given Words

	Foregoing W. - Stimulus	Stimulus-Following W.	Foregoing-Following W.	Average
Adj. - Noun - Verb	.09	.06	.14	.10
Noun - Verb - Noun	.16	.24	.36*	.25
		*	*	
High Frequencies	.10	.16	.27*	.18
Low Frequencies	.15	.15	.22	.18
High Assoc. Strengths	.11	.17	.28*	.19
Low Assoc. Strengths	.15	.14	.19	.16
Average	.12	.15*	.25*	

*Asterics in the first column of numbers indicate significant differences between the resultslisted in columns 1 and 2;in the second column, between the results listed in columns 2 and 3; and in the third column between the results listed in columns 1 and 3. Asterics between the rows of numbers indicate significant differences between the results listed above them. $p<.05$

Table 7

Average Sentence Lengths and Percentages "Correct" for

Similars and Superordinates under Three Conditions*

	Sentence Length			Percentage Correct		
	common	control	creative	common	control	creative
Similars	8.6	13.8	16.5	22	16	18
Superordinates	7.7	11.6	15.7	90	93	79

*Based on the ten word pairs that were administered to Ss under all three conditions.

Table 8

Percentages of Grammatical Classes Used in

Generating Sentences from Similars

	common		control		creative	
	S	R	S	R	S	R
Subject	64	56	45	47	45	35
Object	17	23	22	31	17	24
Pred. Noun	8	10	15	6	11	11
Adv. Location	3	2	6	4	6	6
Attribute	8	9	12	12	21	24
Chi-Square*		2.4		5.3		2.7

*Figures represent comparisons with each of the preceding columns.

Table 9

Percentages of Grammatical Classes Used in

Generating Sentences from Superordinates

	common		control		creative	
	S	R	S	R	S	R
Subject	66	27	53	39	60	34
Object	2	4	9	9	10	15
Pred. Noun	30	49	28	33	20	29
Adv. Location	0	0	0	1	1	1
Attribute	2	20	10	18	9	21
Chi-Square*		36.0***		7.0		12.7**

*Figures represent comparisons with each of the preceding columns.
**p<.05
***p<.01

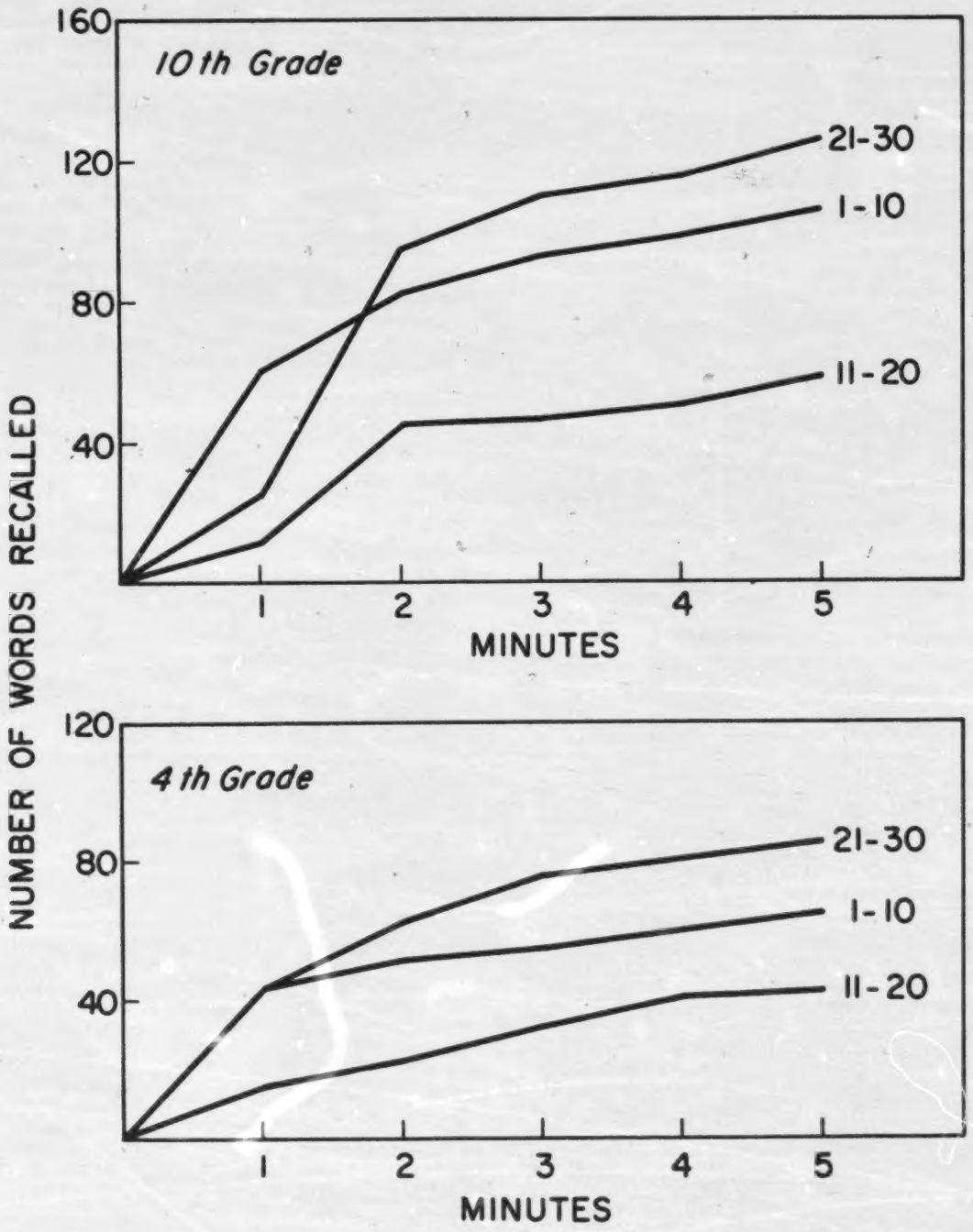

Fig. 1. Cumulative records of the number of words recalled during each minute of five minute intervals for the first ten (1-10) second ten (11-20) and third ten (21-30) words presented and for tenth and fourth graders.

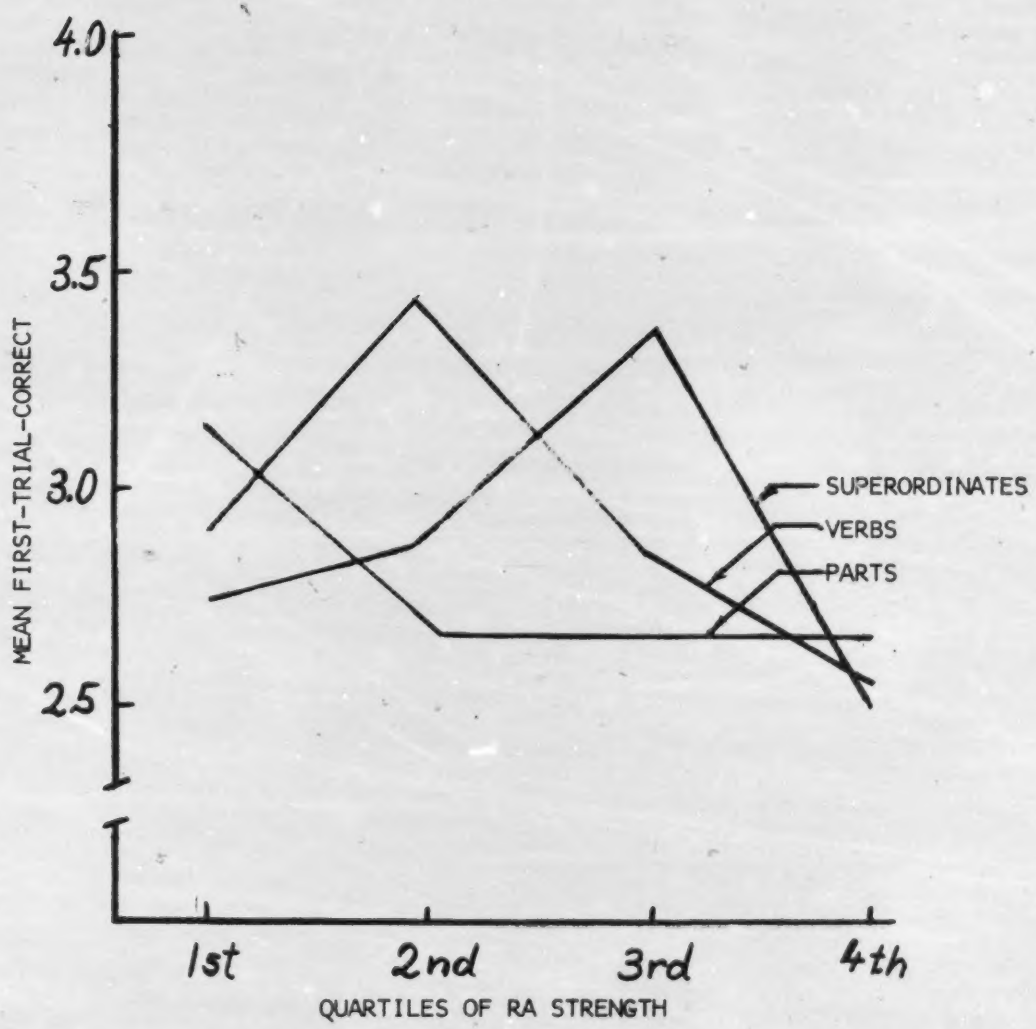

Fig. 2 Mean first-trial-correct for the three relationships at each quartile of restricted association strength.